Physics 115 Lecture 8

Standing waves on a string

February 8, 2018

Class quiz #2: Even though you are far away from an orchestra, the tuba and the piccolo do not sound "out of step" with each other because sound waves

A. are longitudinal.
B. interfere constructively according to their wavelengths.
C. diffract around obstacles.
D. travel at the same speed for all frequencies.

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C. diffract around obstacles.

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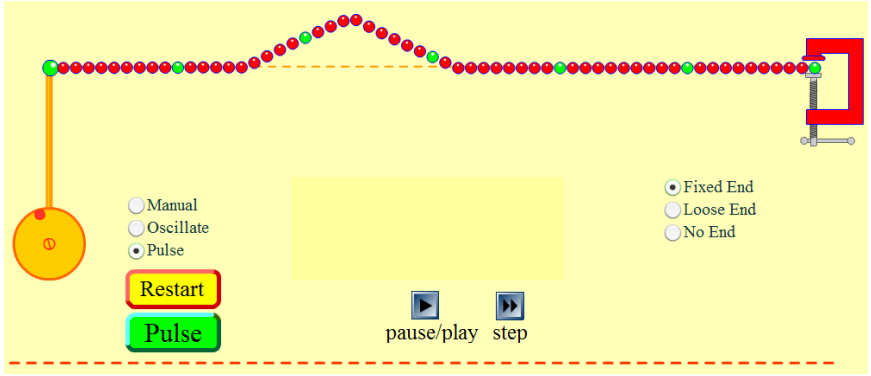
Written quiz #2

- Based on homework #2
- Posted answer key

Waves on a string

- The tension in the string produces the restoring force that allows wave propagation
- Animated applet



Wave speed on a string

- The speed of a wave on a string depends upon the tension in the string (in Newtons) and the mass per unit length (in kg per meter)

$$v = \sqrt{\frac{F\,L}{m}} = \sqrt{\frac{F}{m/L}} = \sqrt{\frac{F}{\mu}}$$

$v =$ wave speed (m/s)

$F =$ string tension (N)

$\mu =$ string mass/length (kg/m)

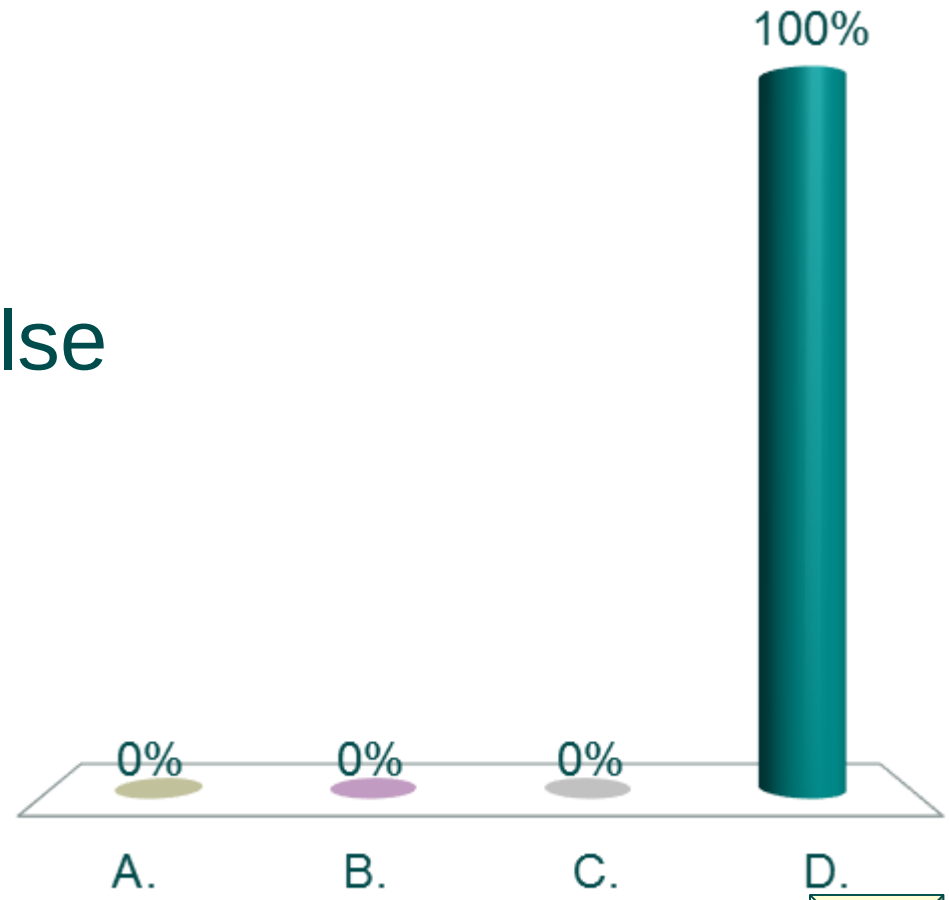
Which of the following affects the speed of a wave pulse on a rope?

A. length of the rope

B. length of the pulse

C. amplitude of the pulse

D. tension in the rope



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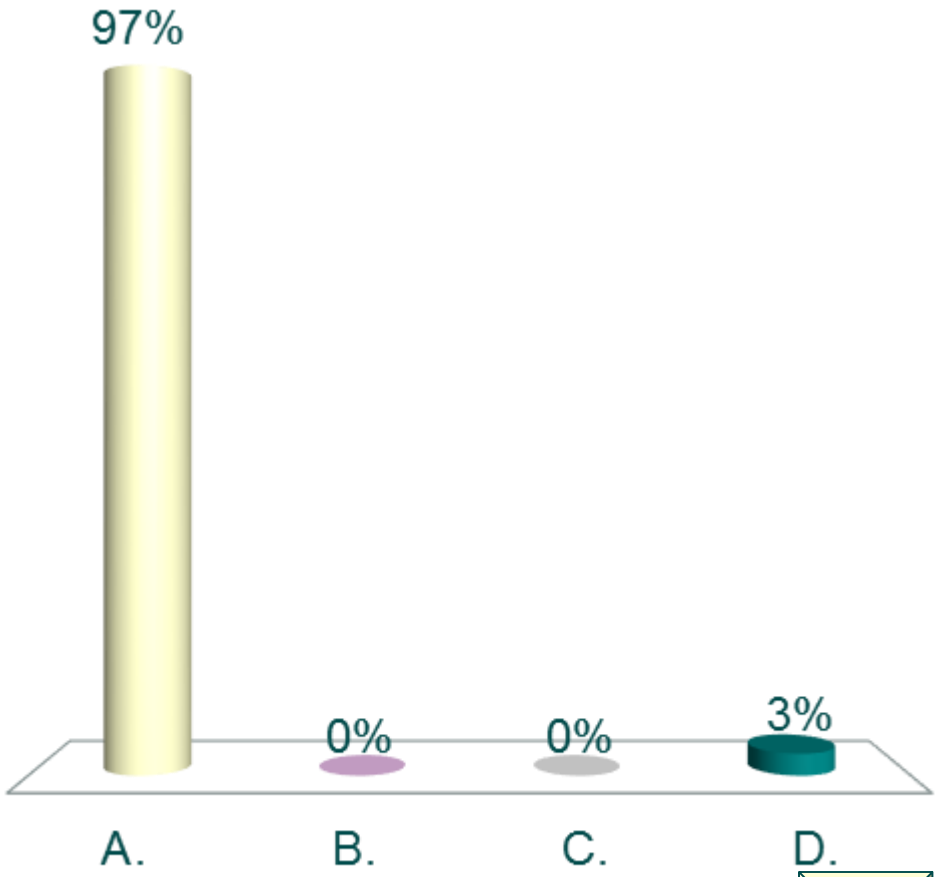
A steel guitar string has a mass per length of 0.0080 kg/m and is under a tension of 415 N. What is the wave speed on this string?

A. 228 m/s

B. 343 m/s

C. 415 m/s

D. 51,900 m/s



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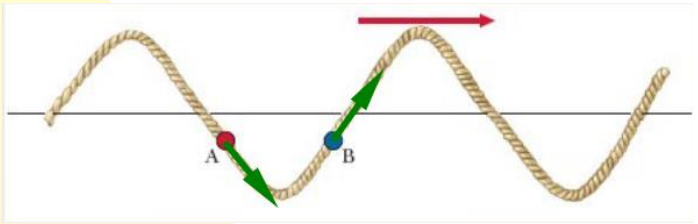
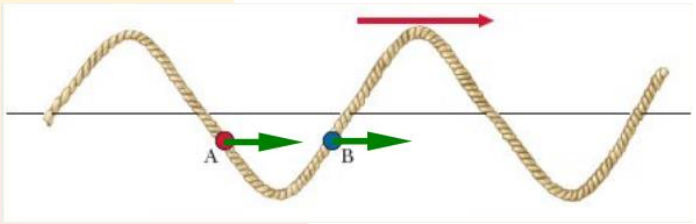
$$v = \sqrt{\frac{F}{\mu}} = \sqrt{\frac{415\ \text{N}}{0.0080\ \text{kg/m}}} = \boxed{228\ \text{m/s}}$$

A periodic wave is traveling to the right on a long, stretched rope. Draw an arrow for points A and B, indicating the direction of velocity.

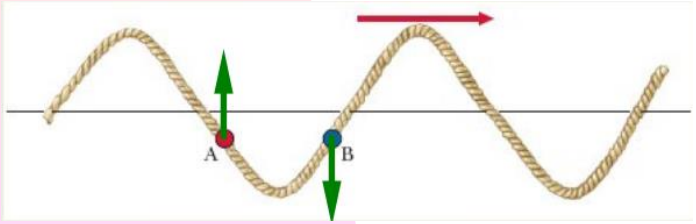
A.



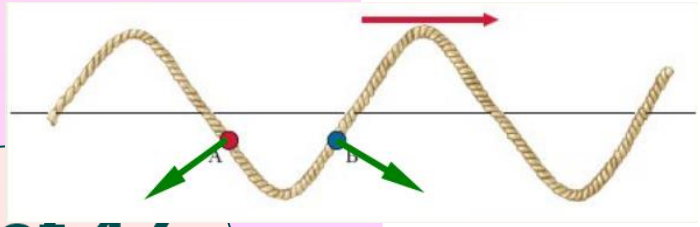
B.

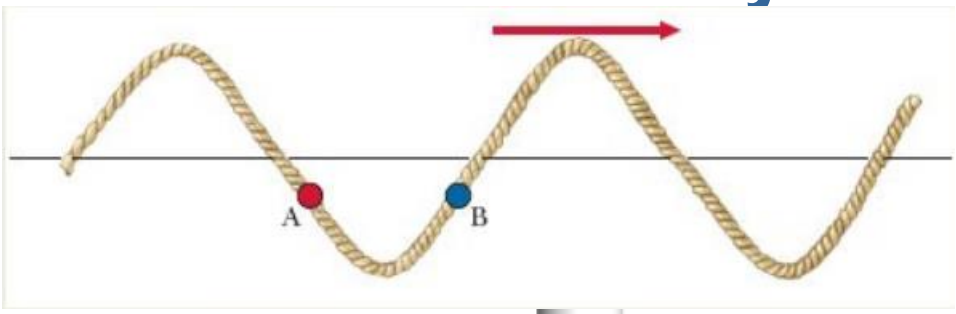


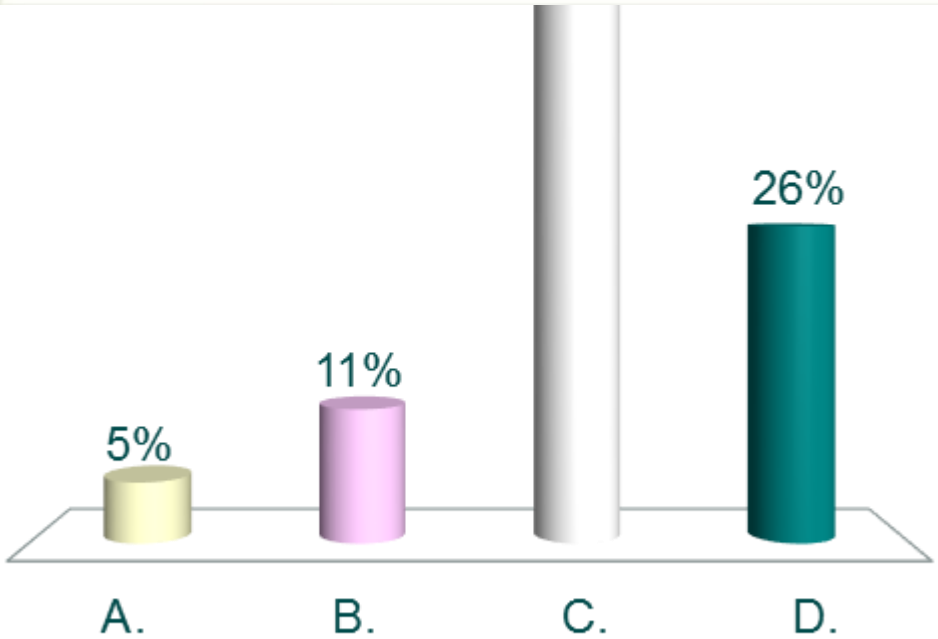
C.



D.







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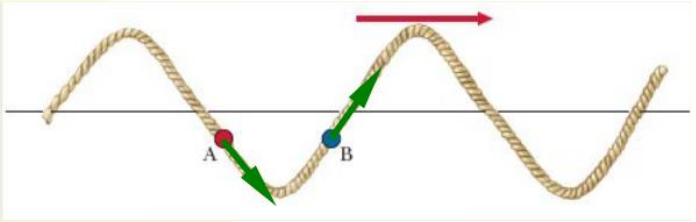
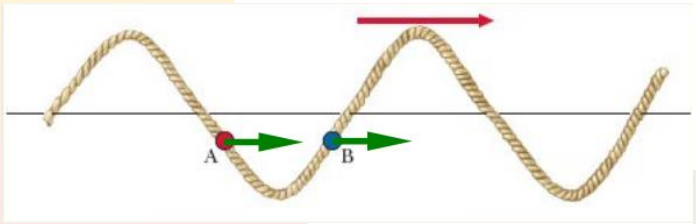
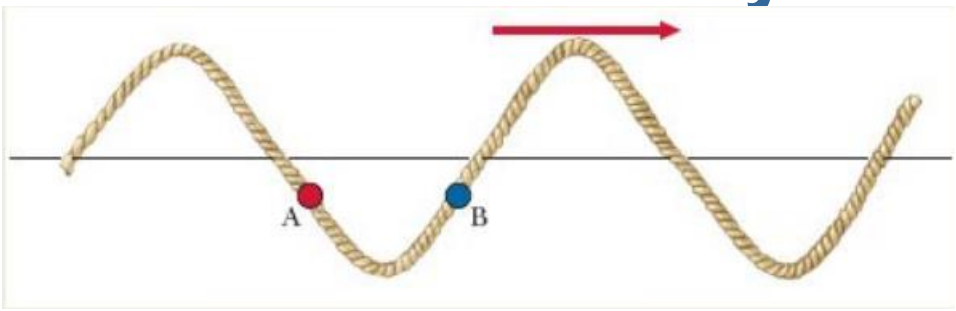
A.

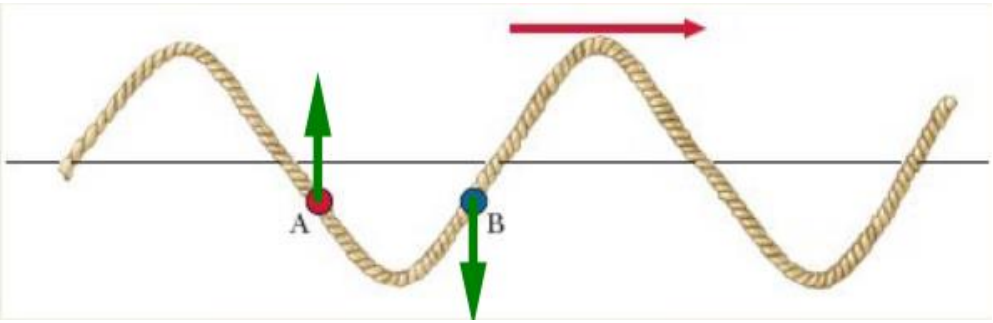


B.

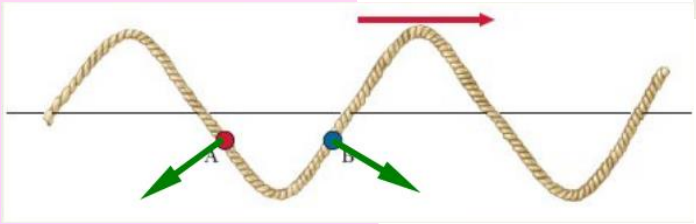


C. transverse wave



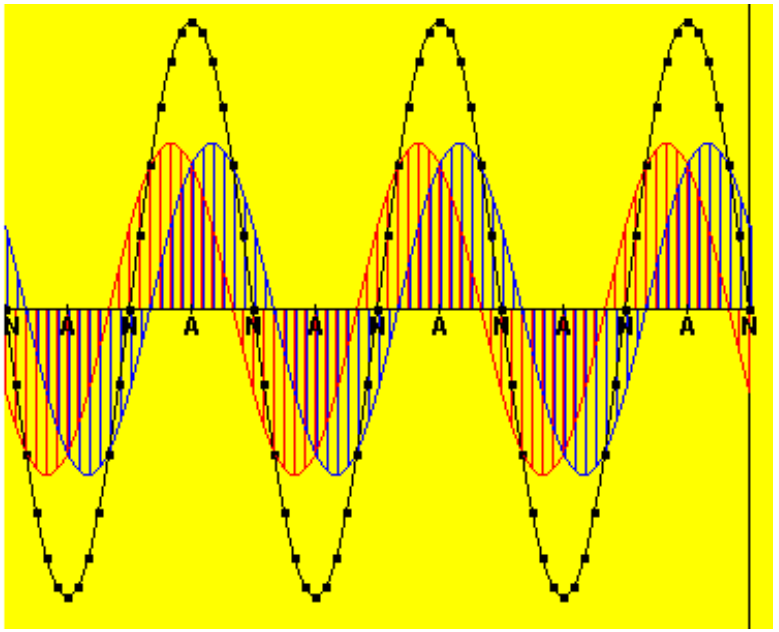


D.



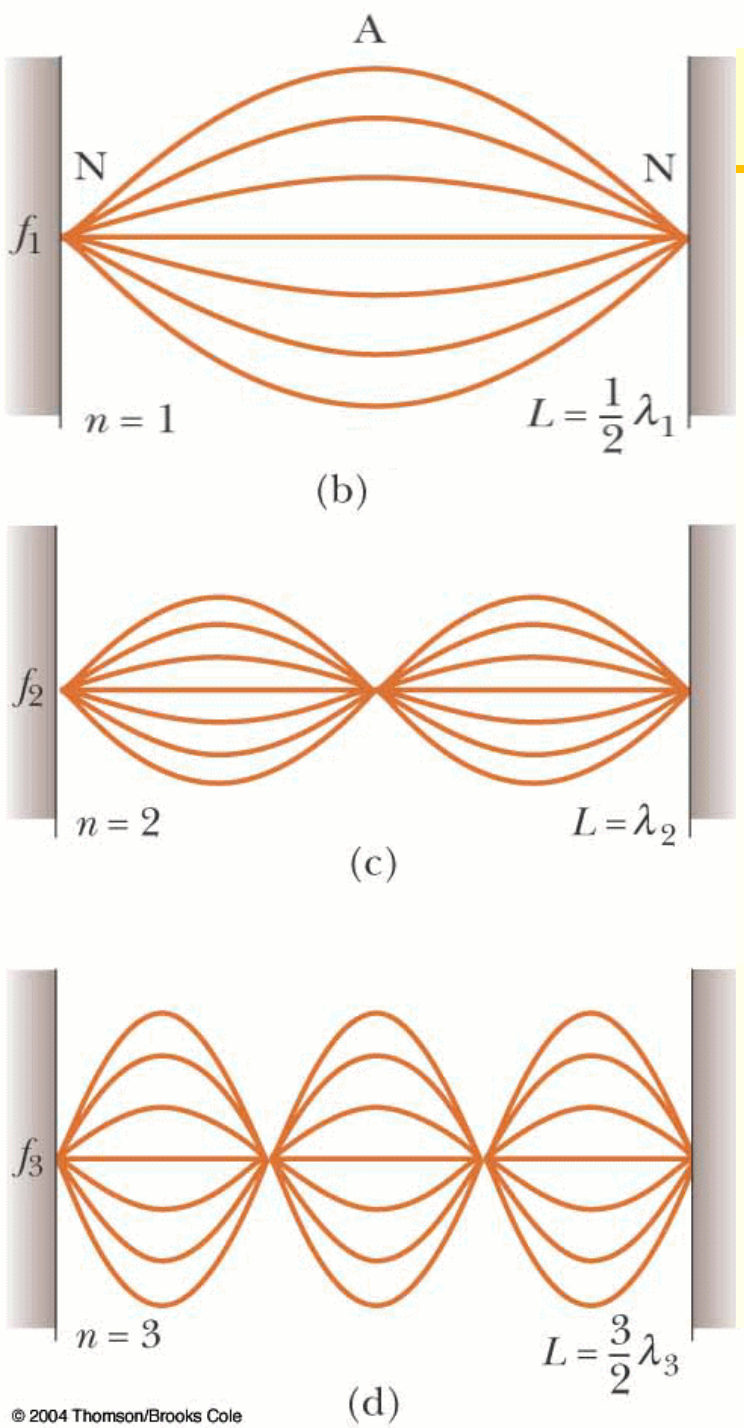
Standing waves

- A standing wave forms when two waves of the same frequency counter propagate in the same medium.
- Constructive interference produces antinodes
- Destructive interference produces nodes
- Animated applet



String fixed at both ends

- Always a node at each end
- Harmonics
- Animated applet
- Video

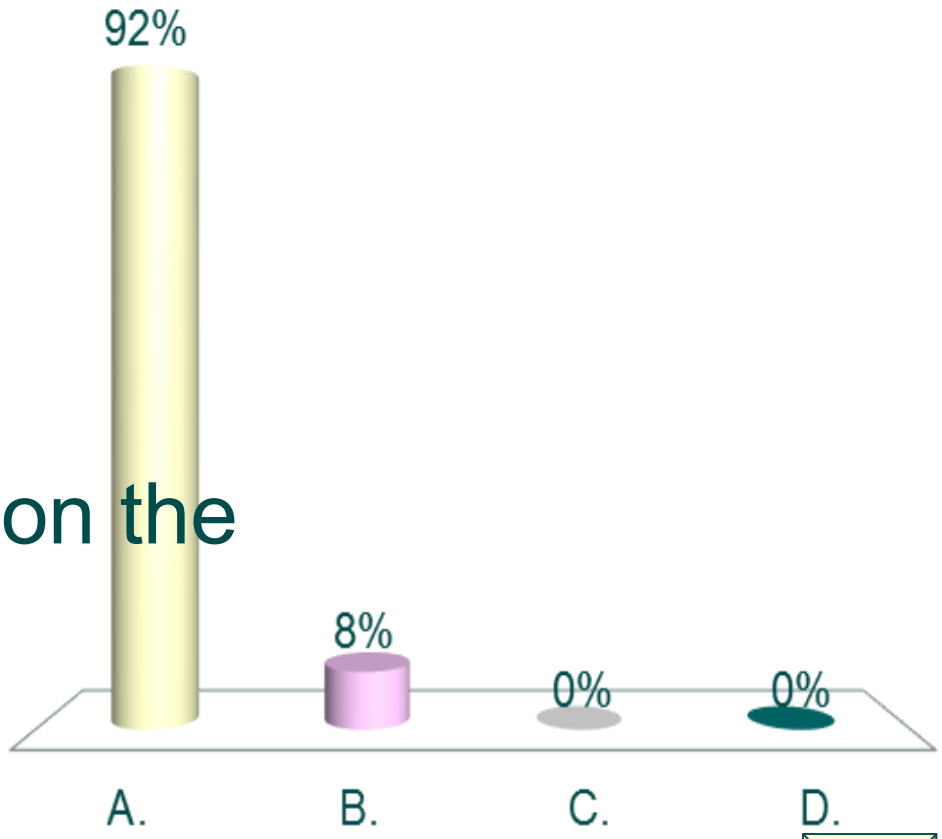


Harmonic	#antinodes	#nodes	λ	f
fundamental	1	2	$\frac{2L}{1}$	f_1
second	2	3	$\frac{2L}{2}$	$2\,f_1$
third	3	4	$\frac{2L}{3}$	$3f_1$

$$c_{\text{string}} = f\lambda$$

Increasing the tension in the string _____ the fundamental frequency of a string.

A. increases
B. decreases
C. does not change
D. can't say; depends on the string



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Increasing the tension in the string _____ the fundamental frequency of a string.

$$f = \frac{v}{\lambda} = \frac{v}{2L} = \frac{1}{2L}\sqrt{\frac{F}{\mu}}$$

A. increases

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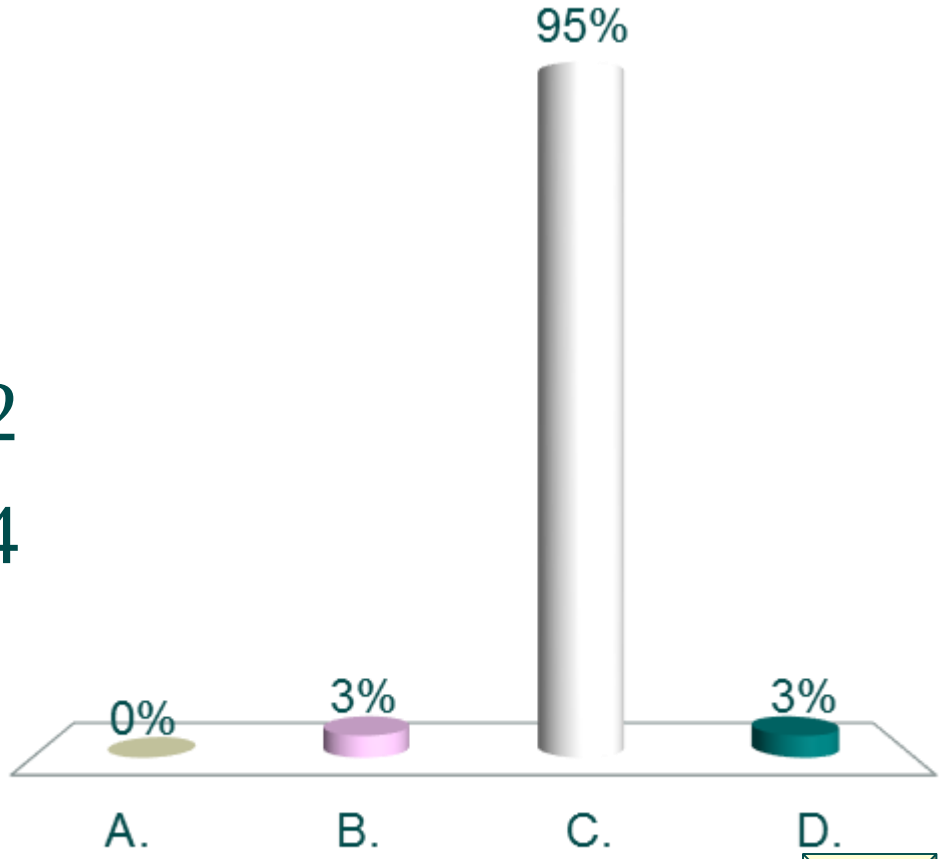
How does the wavelength of the fourth harmonic on a string that is fixed at both ends compare with the length of the string?

A. $\lambda = 4L$

B. $\lambda = 2L$

C. $\lambda = L / 2$

D. $\lambda = L / 4$



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$$\lambda = \frac{2L}{n} = \frac{2L}{4} = \boxed{\frac{L}{2}}$$

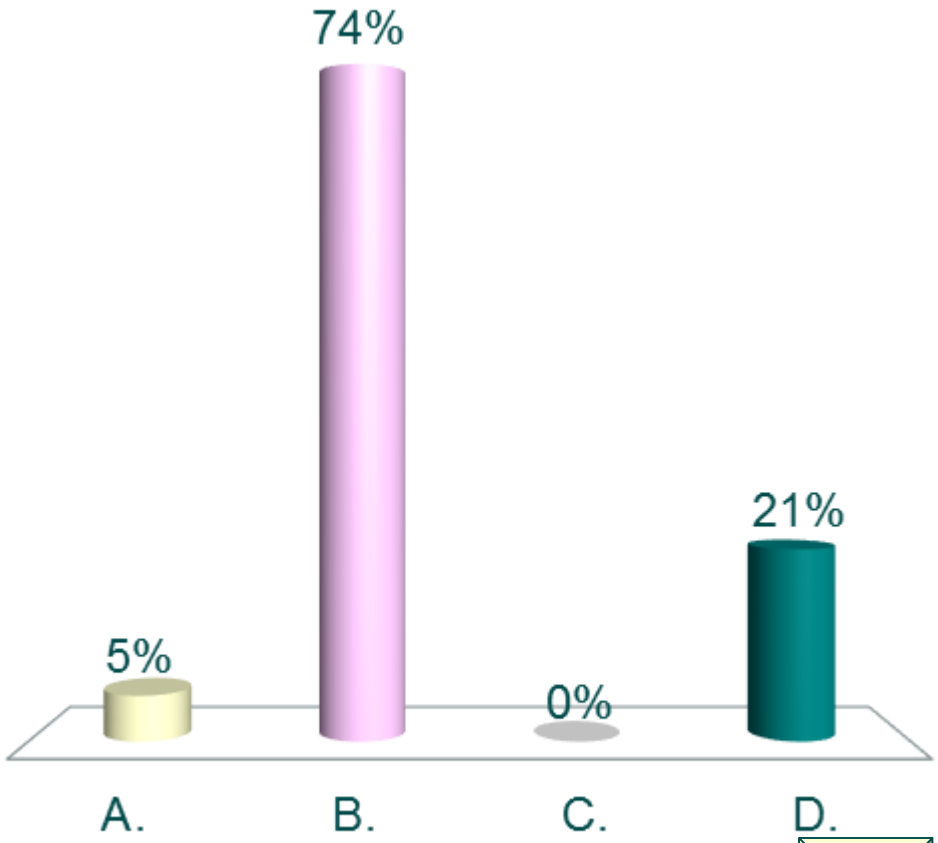
What is the fundamental frequency of a 4-m rope that is fixed at both ends if the speed of the waves is 20 m/s?

A. 20 Hz

B. 5.0 Hz

C. 4.0 Hz

D. 2.5 Hz



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$$f = \frac{v}{\lambda} = \frac{v}{2L} = \frac{20\ \text{m/s}}{2(4.0\ \text{m})} = \boxed{2.5\ \text{Hz}}$$